METRIC

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SUPERSEDING
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PERFORMANCE SPECIFICATION

FIBER, OPTICAL, (METRIC) GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments
and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements and characteristics of optical fibers for signal transmission. The fiber is defined as the core, cladding, and protective coatings applied during the fiber drawing process.

1.2 Classification. The optical fibers specified herein are categorized as follows.

1.2.1 Type. The type designation is defined by the mode volume of the optical fiber.

Type I. Multimode (MM).
Type II. Single-mode (SM).

1.2.2 Class. The class designation for Type I fibers is defined by the nature of refractive index profile, given by the profile parameter (g). The class designation for Type II fibers is determined by the nature of their dispersion characteristics.

Type I fibers.
Class 1. Graded index: 3>g>1.
Class 2. Quasi-graded index: 10>g>3.
Class 3. Step index: g>10.
Class 4. Other.

Type II fibers.
Class 5. Dispersion unshifted.
Class 6. Dispersion shifted.
Class 7. Dispersion flattened.
Class 8. Other.

1.2.3 Composition. The composition designation is defined by the composition of the optical fiber core and cladding (see 6.4) as follows:

A. Glass and glass.
B. Glass and plastic.
C. Plastic and plastic.

Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime-VAT, Post Office Box 3990, Columbus, OH 43218-3990, or emailed to FiberOpticGroup@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

1.2.4 Size. The size designation is defined by the diameters of the optical core and cladding in micrometers (um).

Size I. 4.0 - 8.5 um (Range of nominal mode field diameter at 1550 ± 20 nanometers (nm))/125 µm.
Size II. 8.5 - 10 um (Range of nominal mode field diameter at 1310 ± 20 nanometers (nm))/125 µm.
Size III. 50/125 µm
Size IV. 62.5/125 µm
Size V. 100/140 µm
Size VI. 200/230 µm
Size VII. 400/430 µm

1.2.5 Wavelength. The wavelength designation is defined by the primary wavelengths of operation of the fiber.

A. 850 nm.
B. 850 and 1300 nm.
C. 1300 nm.
D. 1300 and 1550 nm.
E. 1550 nm.

1.3 Part or Identifying Number (PIN). See PIN construction below. Additional manufacturer's marking is allowed.

PIN construction: M 49291 / X - XXX

Military designation
Basic optical fiber specification number
Optical fiber specification sheet number
Two or three digit alpha-numeric

PIN example:
M49291/6-04S would indicate:
- This Military specification
- Specification sheet 6 (Fiber, Optical, Type I, Class I, Size IV, Composition A, Wavelength B, Radiation Resistant (Metric))
- 250 +/-15 um coating diameter, space qualified

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-790 - Standard Practice for Established Reliability and High Reliability Qualified Products List (QPL) Systems for Electrical, Electronic, and Fiber Optic Parts Specifications

MIL-STD-1678-2 - Fiber Optical Cabling System Requirements and Measurements (Part 2: Optical Measurements).

MIL-STD-1678-3 - Fiber Optical Cabling System Requirements and Measurements, Physical, Mechanical, Environmental, and Material Measurements (Part 3 of 5 Parts).

DEPARTMENT OF DEFENSE HANDBOOK

MIL-HDBK-454 - General Guidelines for Electronic Equipment

(Copies of these documents are available online at http://quicksearch.dla.mil or https://assist.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building. 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM-E-595 - Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment. (DoD adopted)

(Copies of these documents are available online at http://www.astm.org or from ASTM International, P.O. Box C700, 100 Barr Harbor Dr. West Conshohocken, PA 19428.)

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

TIA/EIA-455 - Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components. (DoD adopted)
TIA-455-13 - Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies. (DoD adopted)
TIA/EIA-455-20 Measurement of Change in Optical Transmittance. (DoD adopted)
TIA-455-28 - Method For Measuring Tensile Failure Point of Optical Waveguide Fibers. (DoD adopted)
TIA-455-31 - Proof Testing Optical Fibers by Tension. (DoD adopted)
TIA-455-58 - Core Diameter Measurement of Graded-Index Optical Fibers. (DoD adopted)
TIA-455-62 - Measurement of Optical Fiber Macrobend Attenuation. (DoD adopted)
TIA/EIA-455-64 - Procedure for Measuring Radiation-Induced Attenuation in Optical Fibers and Optical Cables
TIA-455-71 - Procedure to Measure Temperature-Shock Effects on Fiber Optic Components.

TIA-455-74	-	FOTP-74 IEC-60793-1-53 Optical Fibres – Part 1-53: Measurement Methods and Test Procedures – Water Immersion
TIA-455-78	-	Part 1-40: Measurement Methods and Test Procedures - Attenuation.
TIA-455-80	-	Cutoff Wavelength of Uncabled Single-Mode Fiber by Transmitted Power. (DoD adopted)
TIA/EIA-455-132	-	Measurement of the Effective Area of Single-Mode Optical Fiber.
TIA-455-133	-	FOTP-133 IEC-60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement
TIA-455-167	-	Mode Field Diameter Method in the Far-Field. (DoD adopted)
TIA-455-175	-	Chromatic Dispersion Measurement of Single-Mode Optical Fibers by the Differential Phase Shift Method. (DoD adopted)
TIA-455-176	-	Method for Measuring Optical Fiber Cross-Sectional Geometry by Automated Grey-Scale Analysis. (DoD adopted)
TIA/EIA-455-177	-	Numerical Aperture Measurement of Graded-Index Optical Fibers. (DoD adopted)
TIA-455-178	-	Measurements of Strip Force for Mechanically Removing Coatings from Optical Fibers. (DoD adopted)
TIA-455-195	-	FOTP-195 IEC-60793-1-21 Optical Fibres – Part 1-21: Measurement Methods and Test Procedures – Coating Geometry .
TIA/EIA-455-204	-	Measurement of Bandwidth on Multimode.
TIA-455-220	-	Differential Mode Delay Measurement of Multimode Fiber in the Time Domain

(Copies of these documents are available online at http://www.tiaonline.org or from the Telecommunications Industry Association/Electronic Industries Association, 2500 Wilson Boulevard, Suite 300, Arlington, Virginia 22201-3836.)

NATIONAL AERONAUTICAL AND SPACE ADMINISTRATION (NASA)

NHB 8060.1	-	Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion.

(Copies of these documents are available online at https://nepp.nasa.gov/ or from the Office of Safety and Mission Quality, (code QR), NASA, Headquarters, Washington, DC 20546.)

NCSL INTERNATIONAL

NCSL Z540.3	-	Requirements for the Calibration of Measuring and Test Equipment

(Copies of this document are available online at http://www.ncsli.org/ or from National Conference of Standards Laboratories, 2995 Wilderness Place, Suite 107, Boulder, CO 80301.)

(Non-Government standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements for optical fibers shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 Qualification. Optical fibers furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.5 and 6.3).

3.3 Verification requirements. The verification requirements of the optical fibers furnished under this specification shall be established and maintained in accordance with the procedures and requirements specified in MIL-STD-790 with details specified in 4.1.

3.4 Materials (see 4.7.2.1.9). The fiber shall be constructed of materials as specified (see 3.1). Materials selected for fiber manufacture shall be of a type and quality to assure compliance with the requirements of this specification, and shall be physically and chemically compatible for their intended use throughout the intended lifetime. All materials used shall be nonconductive unless otherwise specified (see 3.1) and non-nutrient to fungus. Where new and questionable material is being considered for use, the contractor shall furnish the toxicological data required to evaluate the safety of the material for the proposed use. Materials used in fiber construction shall not emit toxic or explosive fumes when exposed to flame, and shall have no adverse effect on the health of personnel when used for their intended purpose.

3.4.1 Recovered materials. Unless otherwise specified herein, all materials incorporated in the products covered by this specification shall be new. Products may be fabricated using raw materials produced from recovered bulk materials to the extent practicable if the intended use of the product is not jeopardized. The term "recovered material" means materials which have been collected or recovered from solid waste and reprocessed to become part of a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of partially processed, assembled, used or rebuilt products are allowed under this specification.

3.4.2 Materials for space applications. When specified, materials used in space flight applications shall meet the following additional material requirements.

3.4.2.1 Thermal vacuum outgassing. When specified, and tested in accordance with 4.7.2.5.1, all non-metallic materials shall not exhibit greater than 1.0 percent total mass loss and shall not produce greater than 0.1 percent collected volatile condensable materials.

3.4.2.2 Odor. When specified, and tested in accordance with 4.7.2.5.2, non-metallic materials shall rate not greater than 2.5.

3.4.2.3 Toxicity. When specified, and tested in accordance with 4.7.2.5.3, all non-metallic materials shall not exceed a total hazard index of 0.5.

3.5 Design and construction (see 4.7.2). The design, construction, and physical dimensions of the complete fiber shall be as specified herein and in the specification sheet (see 3.1).

3.5.1 Optical fiber. Optical fibers shall be sufficiently free of imperfections, inclusions, and impurities other than dopants, to conform to the specified strength and optical transmission requirements. The optical fiber shall be coated with a suitable material to preserve the high pristine tensile strength of the fiber.

3.5.1.1 Splices. Unless otherwise specified (see 3.1 and 6.2), the fibers shall be splice-free. When specified, spliced fibers shall meet all dimensional, mechanical, and environmental requirements as unspliced fiber. The coating of spliced fibers shall be reconstituted in such a manner as to not change the diameter of the coating by more than the percentage specified (see 3.1). When specified, splice loss shall be as specified in the applicable specification sheet (see 3.1).

3.5.1.2 Geometry (fiber). The fiber geometry shall be as specified below.

3.5.1.2.1 Core diameter (Type I fiber only). When tested in accordance with 4.7.2.1.1, the core diameter shall be as specified (see 3.1).

3.5.1.2.2 Mode field diameter (Type II fiber only). When tested in accordance with 4.7.2.1.2, the nominal mode field diameter and mode field diameter tolerance for Type II fiber shall be as specified (see 3.1).

3.5.1.2.3 Core ovality (core noncircularity) (Type I fiber only). When tested in accordance with 4.7.2.1.3, the core ovality shall be as specified (see 3.1).

3.5.1.2.4 Cladding diameter. When tested in accordance with 4.7.2.1.4, the cladding diameter shall be as specified (see 3.1).

3.5.1.2.5 Cladding ovality (cladding noncircularity). When tested in accordance with 4.7.2.1.5, the cladding ovality shall be as specified (see 3.1).

3.5.1.2.6 Core-to-cladding offset (core/cladding concentricity). When tested in accordance with 4.7.2.1.6, the core-to-cladding offset shall be as specified (see 3.1).

3.5.1.2.7 Coating diameter. When tested in accordance with 4.7.2.1.7, the coating diameter shall be as specified (see 3.1).

3.5.1.2.8 Overall coating concentricity error. When tested in accordance with 4.7.2.1.8, the overall coating concentricity error shall be as specified (see 3.1).

3.5.1.3 Fiber mass/unit length (kg/km). When tested in accordance with 4.7.2.2, the fiber mass/unit length expressed as kilograms/kilometer shall be as specified (see 3.1).

3.5.2 Tensile proof. When tested in accordance with 4.7.2.3, the proof tested tensile strength of the fiber shall be as specified (see 3.1).

3.5.3 Mechanical strippability. When tested in accordance with 4.7.2.4, the fiber coating shall be mechanically strippable with commercially available stripping tools. There shall be no scratches, nicks, or inclusions in the stripped fibers or residual coating material on the stripped fiber which cannot be easily removed with a cotton pad or a wipe moistened with a fiber optic grade cleaning solution. For 250 µm coating, the maximum strip force shall be not less than 1.8 N and not greater than 13.2 N. For 500 µm coatings, the maximum strip force shall be not less than 1.8 N and not greater than 20 N.

3.5.4 Continuous lengths. Unless otherwise specified (see 3.1), the individual continuous lengths of finished fiber in each unit of product shall be 1100 meters minimum. A spool shall contain no more than one continuous length of fiber.

3.6 Optical performance.

3.6.1 Change in optical transmittance. When tested in accordance with 4.7.3.1, the change in optical transmittance for the specified sample due to exposure of fiber to mechanical and environmental tests shall be not greater than 0.5 decibel (dB) for Type I fibers and 0.3 dB for Type II fibers.

3.6.2 Attenuation rate. When tested in accordance with 4.7.3.2, the fiber attenuation rate at the wavelengths of operation shall be as specified (see 3.1).

3.6.2.1 Attenuation uniformity. When tested in accordance with 4.7.3.2.3, there shall be no discontinuities in attenuation along the length of the Type I fiber greater than 0.2 dB and no discontinuities in attenuation along the length of the Type II fiber greater than 0.1 dB, for the specified wavelength.

3.6.3 Numerical aperture (for Type I fiber only). When applicable (see 3.1) and when tested in accordance with 4.7.3.3, the numerical aperture shall be as specified.

3.6.4 Bandwidth (for Type I fiber only). When tested in accordance with 4.7.3.4, the fiber bandwidth at the wavelengths of operation shall be as specified (see 3.1).

3.6.5 Macrobend attenuation. When tested in accordance with 4.7.3.5, the macrobend attenuation shall be not greater than 0.5 dB for Type I fibers and the macrobend attenuation shall be not greater than 0.1 dB at 1300 ± 20 nm or 1.0 dB at 1550 ± 25 nm for Type II fibers unless otherwise specified (see 3.1). The mandrel radius shall be 3.8 ± 0.05 centimeters and the number of turns shall be 100.

3.6.6 Chromatic dispersion. When tested in accordance with 4.7.3.6, unless otherwise specified, the zero dispersion wavelength of dispersion-unshifted Type II fibers shall be 1310 ± 15 nm with a maximum dispersion value of 3.5 picoseconds per nanometer-kilometer (ps/nm-km) from 1290 to 1330 nm. When specified, the dispersion at other wavelengths shall be as specified (see 3.1). The value of the dispersion slope at the zero dispersion wavelength shall be not greater than 0.1 ps/nm^2-km. The dispersion characteristics for all other Type II fibers shall be as specified (see 3.1). When specified, the Type I fiber zero dispersion wavelength and the dispersion slope at the zero dispersion wavelength shall be as specified (see 3.1).

3.6.7 Cut-off wavelength (for Type II fiber only). When tested in accordance with 4.7.3.7, unless otherwise specified (see 3.1), the cut-off wavelength of dispersion unshifted Type II fibers shall be between 1130 and 1330 nm. The cutoff wavelength for all other Type II fibers shall be as specified (see 3.1).

3.6.8 Transient attenuation (for Type I fiber only). When specified and when tested in accordance with 4.7.3.8, the transient attenuation for Type I fibers shall be as specified (see 3.1).

3.7 Environmental performance.

3.7.1 Thermal shock. When tested in accordance with 4.8.1, there shall be no cracking or melting of the fiber coating material and the change in optical transmittance shall not exceed the requirements of 3.6.1.

3.7.2 Temperature humidity cycling. When tested in accordance with 4.8.2, there shall be no swelling or softening of the coating material which causes the fiber diameter or length to exceed the specified dimensional tolerances (see 3.1). The change in optical transmittance shall not exceed the requirements of 3.6.1. The mechanical strippability requirements of 3.5.3 shall be met.

3.7.3 Temperature cycling. When tested in accordance with 4.8.3, there shall be no cracking or melting of the fiber coating material and the change in optical transmittance shall not exceed the requirements of 3.6.1.

3.7.4 Life aging. When tested in accordance with 4.8.4, the change in optical transmittance shall not exceed the requirements of 3.6.1. When returned to ambient temperature, visual inspection in accordance with 4.7.2 shall reveal no cracking or melting of the fiber coatings and the fiber coatings shall meet the mechanical strippability requirements of 3.5.3.

3.7.5 Fluid immersion aging. When specified (see 3.1) and when tested in accordance with 4.8.5, after removal of test specimens from the test fluid, the specimen shall meet all the requirements of 3.7.8.

3.7.6 Nuclear radiation resistance. When specified (see 3.1) and when tested in accordance with 4.8.6, the nuclear radiation resistance requirements shall be as specified (see 3.1).

3.7.7 Fungus resistance. When specified, and when tested in accordance with 4.8.7, polymeric fiber materials shall show sparse or very restricted microbial growth and reproduction with minor or inhibited substrate utilization. There shall be little or no chemical, physical, or structural change detectable.

3.7.8 Dynamic tensile strength. When specified (see 3.1) and when tested in accordance with 4.8.8, the mean fracture strength after each period of aging shall be not less than 1.75 gigaPascals (GPa). The initial mean fracture strength shall be not less than 3.2 GPa. The Weibull modulus shall be reported.

3.7.9 Storage temperature. When specified (see 3.1) and when tested in accordance with 4.8.9, there shall be no cracking or melting of the fiber coating material and the change in optical transmittance shall not exceed the requirements of 3.6.1.

3.8 Identification marking. Unless otherwise specified in the acquisition document or in the specification sheet (see 3.1), the identification shall be applied to either the outer surface of the fiber spool or the outside of the container holding the fiber spool. Identification marking shall include indicators of the military specification number, specification sheet number, military Part or Identifying Number (PIN), manufacturer's code, and a four character date code indicating week and year. All markings shall be permanent and legible. When specified (see 3.1 and 6.2), a colored coating of the optical fiber shall be as specified (see 3.1 and 4.7.2).

3.8.1 JAN and J marking. The United States Government has adopted and is exercising legitimate control over the certification marks “JAN” and “J”, respectively, to indicate that items so marked or identified are manufactured to, and meet all the requirements of specifications. Accordingly, items acquired to, and meeting all of the criteria specified herein and in applicable specifications shall bear the certification mark “JAN” except that items too small to bear the certification mark “JAN” shall bear the letter “J”. The “JAN” or “J” shall be placed immediately before the part number except that if such location would place a hardship on the manufacturer in connection with such marking, the “JAN” or “J” may be located on the first line above or below the part number. Items furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein or in applicable specifications shall not bear “JAN” or "J". In the event an item fails to meet the requirements of this specification and the applicable specification sheets, the manufacturer shall remove completely the military part number and the “JAN” or the “J” from the sample tested and also from all items represented by the sample. The “JAN” or “J” certification mark shall not be used on products acquired to contractor drawings or specifications. The United States Government has obtained Certificate of Registration Number 504,860 for the certification mark “JAN” and Registration Number 2,577,735 for the certification mark “J”.

3.9 Workmanship (see 4.7.2). All details of workmanship shall be in accordance with high grade optical fiber manufacturing practice. Fibers shall be dimensionally uniform, free of lumps, kinks, splits, scraped or abraded surfaces and inclusions.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.5).

b. Conformance inspection (see 44.6).

4.2 Verification program. A verification program shall be established and maintained in accordance with MIL-STD-790 or comparable standard. Evidence of such compliance shall be verified by the qualifying activity of this specification as a prerequisite for qualification and continued qualification. Results of audits to MIL-STD-790 equivalent quality assurance standards by third parties shall be available to the Government for review. The verification system procedures, planning, and all other documentation and data that comprise the verification system shall be available to the Government for review. The Government may perform any necessary inspections, verifications, and evaluations to ascertain conformance to the requirements and the adequacy of the implementing procedures.

4.3 Test equipment and inspection facilities. Provision for test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspections shall be the responsibility of the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with NCSL Z540.3 or comparable standard.

4.4 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the standard test conditions specified in TIA/EIA-455.

4.5 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures normally used in production. Group qualification shall be as specified in 4.5.2.

4.5.1 Sample. A finished optical fiber sample shall be submitted for each fiber construction (see 3.1) for which qualification is desired (see 6.3.2). The sample size, unless otherwise specified (see 3.1), submitted shall be 3 units each of 2.2 km minimum lengths with no splices.

4.5.2 Group qualification. In instances where two or more fibers are identical in materials and construction except for attenuation, the fiber with the lowest attenuation range shall be submitted and shall meet all the requirements of this specification and the specification sheet (see 3.1). Qualification may be extended to include those fibers with higher attenuation provided the samples submitted in accordance with 4.5.1 meet the attenuation and fiber size specified in the specification sheet.

4.5.3 Inspection routine. The samples shall be subjected to the qualification inspection specified in table I. Group I inspections may be performed in any order, however groups II and III inspections shall be performed in the order shown. In cases where certain requirements and tests are applicable only when specified (see 3.1), these tests shall be conducted in the order shown when specified in the appropriate specification sheet (see 3.1). Tests which are not specified as applicable to a specific fiber construction shall not be conducted. All sample units shall be subjected to the inspection of group I. Specimens shall be cut from each sample unit in lengths at least as long as specified in table I. Test specimens from each sample unit shall be subjected to the tests of groups II and III, of table I; however, each test specimen shall be subjected to only one group of tests in addition to group I.

4.5.4 Failures. One or more failures shall be cause for refusal to grant qualification approval.

4.5.5 Retention of qualification. To retain qualification, the contractor shall verify in coordination with the qualifying activity the capability of manufacturing products which meet the performance requirements of this specification. Refer to the qualifying activity for the guidelines necessary to retain qualification to this particular specification. The manufacturer shall immediately notify the qualifying activity at any time that the inspection data indicates failure of the qualified product to meet the performance requirements of this specification.

4.6 Conformance inspection. Conformance inspection shall consist of the inspections and tests specified for group A inspection (see table II), group B inspection (see table III), and group C inspection (see table IV). Requests for alternate forms of conformance inspection shall be submitted to the qualifying activity. Alternate forms of conformance inspection may be used upon written approval by the qualifying activity.

TABLE I. Qualification inspection.

Inspection	Requirement paragraph	Test paragraph	Applicable test document	Specimen length
Group I				
Visual and mechanical inspection	3.4, 3.5, 3.8, 3.9	4.7.2	TIA-455-13 TIA-455-133	3 at 2.2 km 1/
Core diameter	3.5.1.2.1	4.7.2.1.1	TIA-455-58	2/, 3/, 4/
Mode field diameter	3.5.1.2.2	4.7.2.1.2	TIA-455-167 or TIA/EIA-455-132	2/, 4/, 5/
Core ovality	3.5.1.2.3	4.7.2.1.3	TIA-455-176	2/, 3/
Cladding diameter	3.5.1.2.4	4.7.2.1.4	TIA-455-176	2/
Cladding ovality	3.5.1.2.5	4.7.2.1.5	TIA-455-176	2/
Core-to-cladding offset	3.5.1.2.6	4.7.2.1.6	TIA-455-176	2/
Coating diameter	3.5.1.2.7	4.7.2.1.7	TIA-455-195	2/
Overall coating concentricity error	3.5.1.2.8	4.7.2.1.8	TIA-455-195	2/
Fiber mass/unit length	3.5.1.3	4.7.2.2	TIA-455-195	2/
Materials inspection	3.4	4.7.2.1.9		
Attenuation rate Type I fiber Type II fiber	3.6.2	 4.7.3.2.1 4.7.3.2.2	 MIL-STD-1678-2 Measurement 2106	 4/, 6/, 7/ 4/, 6/, 7/
Attenuation uniformity	3.6.2.1	4.7.3.2.3	TIA-455-78	6/
Numerical aperture	3.6.3	4.7.3.3	TIA/EIA-455-177	2/, 3/, 4/
Bandwidth	3.6.4	4.7.3.4	TIA/EIA-455-204 or TIA-455-220	3/, 4/, 6/
Macrobend attenuation	3.6.5	4.7.3.5	TIA-455-62	4/, 6/
Chromatic dispersion	3.6.6	4.7.3.6	TIA-455-175	4/, 6/
Cut-off wavelength	3.6.7	4.7.3.7	TIA-455-80	2/, 4/, 5/
Transient attenuation	3.6.8	4.7.3.8	TIA-455-78	3/, 4/, 8/
Group II				
Tensile proof	3.5.2	4.7.2.3	TIA-455-31	3 at 2.2 km
Nuclear radiation resistance	3.7.6	4.8.6	TIA/EIA-455-64	9/, 10/
Mechanical strippability	3.5.3	4.7.2.4	TIA-455-178	11/
Fluid immersion aging	3.7.5	4.8.5	TIA-455-74	11/
Dynamic tensile strength	3.7.8	4.8.8	TIA-455-28	12/
Group III				
Thermal shock	3.7.1	4.8.1	TIA-455-71	13/, 14/
Storage temperature	3.7.9	4.8.9		15/
Temperature humidity cycling	3.7.2	4.8.2	MIL-STD-1678-3 Measurement 3302	15/
Temperature cycling	3.7.3	4.8.3	MIL-STD-1678-3 Measurement 3301	15/
Life aging	3.7.4	4.8.4	MIL-STD-1678-3 Measurement 3303	15/
Fungus resistance	3.7.7	4.8.7	MIL-STD-1678-3 Measurement 3401	9/

See footnotes at end of table.

TABLE I. Qualification inspection (continued).

Inspection	Requirement paragraph	Test paragraph	Applicable test document	Specimen length
Group IV				
Thermal vacuum outgassing	3.4.2.1	4.7.2.5.1	ASTM E595	16/
Odor	3.4.2.2	4.7.2.5.2	NHB-8060.1	16/
Toxicity	3.4.2.3	4.7.2.5.3	NHB-8060.1	16/

1/ The visual and mechanical inspection shall only be conducted on a 2 m section of each sample unit.
2/ A specimen cut from each 2.2 km sample unit shall be used.
3/ Type I fiber only.
4/ Fiber parameter test.
5/ Type II fiber only.
6/ The same 2.2 km sample units used in the visual and mechanical inspection shall be used.
7/ Group I tests may be performed on shipping spools, measurement spools or in a loose coil. If fiber parameter tests are conducted on fiber on shipping spools and the results of any fiber parameter test is not within specification, all fiber parameter tests shall be conducted on fiber on measurement spools or in loose coils.
8/ One sample unit shall be used for this test.
9/ A specimen cut from each 2.2 km tensile proof test sample unit.
10/ The fiber length shall be > 200 m for residual gamma testing and > 20 m for prompt gamma and neutron testing from each specimen. Each specimen shall be tested at one temperature.
11/ Specimens cut from each 2.2 km tensile proof test shall be used.
12/ The same specimens used in the fluid immersion aging test shall be used.
13/ The remaining portion of the three 2.2 km sample units used in the tensile proof test shall be used.
14/ Group III environmental tests shall be conducted with each 2.2 km specimen in a loose coil.
15/ The same specimens used in the thermal shock test shall be used.
16/ Finished material from a fiber sample.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspection.

4.6.1.1 Unit of product. A unit of product shall be 1100 meters minimum.

4.6.1.2 Production unit. The production unit shall consist of the number of units of product produced on the same production line or lines, and offered for inspection at one time. All of the units of product in the production unit submitted shall have been produced during the same production period with the same materials and processes.

4.6.1.3 Specimen. A specimen shall be an individual length of fiber cut from the sample. Unless otherwise specified, a minimum of the specimens shall be inspected and tested from each sample.

4.6.2 Group A inspection. Group A inspection shall consist of the inspections and tests specified in table II.

4.6.2.1 Sampling plan. Group A inspection shall be performed on 100 percent of delivered product.

4.6.2.2 Disposition of sample units. Sample units from which a specimen has failed any of the group A inspection tests shall not be delivered on any order.

TABLE II. Group A inspection.

Inspection	Requirement paragraph	Test paragraph	Applicable test document
Visual and mechanical inspection	3.4, 3.5, 3.8, 3.9	4.7.2	TIA-455-13, TIA-455-133
Attenuation rate Type I Type II	3.6.2	 4.7.3.2.1 4.7.3.2.2	 MIL-STD-1678-2 Measurement 2106
Attenuation uniformity	3.6.2.1	4.7.3.2.3	TIA-455-78

4.6.3 Group B inspection. Group B inspection shall consist of the inspections specified in table III. Group B inspections shall be made on units that have passed the group A inspection. The maximum time from the end of one group B inspection to the beginning of the following group B inspection shall be not greater than 24 months.

4.6.3.1 Sampling plan. Group B inspections shall be performed on 100 percent of product covered by each specification sheet.

4.6.3.2 Failures. Production units in which one sample unit has failed a group B inspection test shall be rejected.

4.6.3.3 Rejected units. If a production unit is rejected, the supplier may screen out the defective units of product (if possible), and resubmit for reinspection. Resubmitted production units shall be inspected using tightened sampling. Such production units shall be separate from new production units, and shall be clearly identified as reinspected production units.

4.6.3.4 Disposition of sample units. Sample units from which a specimen has failed any of the group B inspections shall not be delivered on any order, even though the production unit submitted is accepted.

TABLE III. Group B inspection.

Inspection	Requirement paragraph	Test paragraph	Applicable test document
Mode field diameter	3.5.1.2.2	4.7.2.1.2	TIA-455-167 or TIA/EIA-455-132
Core diameter	3.5.1.2.1	4.7.2.1.1	TIA-455-58
Cladding diameter	3.5.1.2.4	4.7.2.1.4	TIA-455-176
Cladding ovality	3.5.1.2.5	4.7.2.1.5	TIA-455-176
Core ovality	3.5.1.2.3	4.7.2.1.3	TIA-455-176
Core-to-cladding offset	3.5.1.2.6	4.7.2.1.6	TIA-455-176
Coating diameter	3.5.1.2.7	4.7.2.1.7	TIA-455-195
Overall coating concentricity error	3.5.1.2.8	4.7.2.1.8	TIA-455-195
Material inspection	3.4	4.7.2.1.9	
Numerical aperture	3.6.3	4.7.3.3	TIA/EIA-455-177
Cut-off wavelength	3.6.7	4.7.3.7	TIA-455-80
Tensile proof	3.5.2	4.7.2.3	TIA-455-31

4.6.4 Group C inspection. Group C inspection shall consist of the inspections specified in table IV. Group C inspection shall be made on sample units selected from production lots which have passed the groups A and B inspections.

4.6.4.1 Sampling plan. Three sample units shall be selected from those types covered by a single specification sheet. Group C shall be conducted 60 months after the date of notification of qualification, and every 60 months thereafter, except when the total production in a 60-month period is less than 11 units of product; inspection need not be made until production is at least 11 units of product.

4.6.4.2 Failures. If one or more sample units fail to pass group C inspection, the production unit shall be considered to have failed.

4.6.4.3 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on the contract.

4.6.4.4 Noncompliance. If a sample fails to pass group C inspection, the supplier shall notify the qualifying activity and the cognizant inspection activity and take corrective action on the materials or processes, or both, as warranted. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspections, or the inspection which the original sample failed, at the option of the Government). Groups A and B inspections may be reinstituted; however, final acceptance shall be withheld until the group C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and corrective action taken shall be furnished to the cognizant inspection activity and the qualifying activity.

TABLE IV. Group C inspection.

Inspection	Requirement paragraph	Test paragraph	Applicable test document
Subgroup I			
Macrobend attenuation	3.6.5	4.7.3.5	TIA-455-62
Storage temperature	3.7.9	4.8.9	
Temperature humidity cycling	3.7.2	4.8.2	MIL-STD-1678-3 Measurement 3302
Temperature cycling	3.7.3	4.8.3	MIL-STD-16778-3 Measurement 3301
Life aging	3.7.4	4.8.4	MIL-STD-1678-3 Measurement 3303
Subgroup II			
Mechanical strippability	3.5.3	4.7.2.4	TIA-455-178
Fluid immersion aging	3.7.5	4.8.5	TIA-455-74
Dynamic tensile strength	3.7.8	4.8.8	TIA-455-28
Subgroup III 1/			
Thermal vacuum outgassing	3.4.2.1	4.7.2.5.1	ASTM E595
Odor	3.4.2.2	4.7.2.5.2	NHB-8060.1
Toxicity	3.4.2.3	4.7.2.5.3	NHB-8060.1

1/ These tests may be waived by the qualifying activity.

4.7 Methods of inspection.

4.7.1 Equivalent test methods. The use of equivalent test methods is allowed subject to the following conditions:

a. The allowance of an equivalent method is specified in this specification.

b. The manufacturer has conducted both test methods and has submitted complete test data to the Preparing Activity (PA).

c. The PA has approved the use of that method by that manufacturer.

4.7.2 Visual and mechanical inspection. The optical fiber shall be inspected in accordance with TIA-455-13 to verify that the design, construction, physical characteristics and dimensions, marking, and workmanship are in accordance with the requirements of 3.4, 3.5, 3.8, and 3.9. Fiber length shall be measured in accordance with TIA-455-133.

4.7.2.1 Fiber geometry. Fiber geometry shall be determined as specified below.

4.7.2.1.1 Core diameter (Type I fiber only). Core diameter shall be determined in accordance with TIA-455-58 (see 3.5.1.2.1).

4.7.2.1.2 Mode field diameter (Type II fiber only). Mode field diameter shall be determined in accordance with TIA-455-167 or TIA/EIA-455-132 method A (see 3.5.1.2.2). In the case of a dispute between the two test methods, TIA-455-167 shall be used.

4.7.2.1.3 Core ovality (core noncircularity) (Type I fiber only). Core ovality shall be determined in accordance with TIA-455-176 (see 3.5.1.2.3).

4.7.2.1.4 Cladding diameter. Cladding diameter shall be determined in accordance with TIA-455-176 (see 3.5.1.2.4).

4.7.2.1.5 Cladding ovality (cladding noncircularity). Cladding ovality shall be determined in accordance with TIA-455-176 (see 3.5.1.2.5).

4.7.2.1.6 Core-to-cladding offset (core/cladding concentricity). Core-to-cladding offset shall be determined in accordance with TIA-455-176 (see 3.5.1.2.6).

4.7.2.1.7 Coating diameter. Coating diameter shall be determined in accordance with TIA-455-195 (see 3.5.1.2.7).

4.7.2.1.8 Overall coating concentricity error. The overall coating concentricity error shall be determined in accordance with TIA-455-195 (see 3.5.1.2.8).

4.7.2.1.9 Materials inspection. Materials inspection shall consist of certification, supported by verifying data, that materials used in fabricating the delivered fiber are in accordance with the requirements of 3.4 and as specified (see 3.1).

4.7.2.2 Fiber mass/unit length. The fiber mass per unit length shall be determined in accordance with EIA/TIA-455-173 using scales with an accuracy of ±5 percent or better to verify conformance to the requirements (see 3.5.1.3).

4.7.2.3 Tensile proof. Fiber proof test characteristics shall be determined in accordance with TIA-455-31 (see 3.5.2).

4.7.2.4 Mechanical strippability. The strip force of each individual fiber shall be measured in accordance with TIA-455-178. Fibers shall be stripped of their coatings with the use of a commercially available mechanical fiber stripper. After stripping, the fiber shall be inspected under 10X magnification for compliance (see 3.5.3).

4.7.2.5 Materials tests for space applications.

4.7.2.5.1 Thermal vacuum outgassing. Non-metallic materials shall meet the requirements of 3.4.2.1 when tested in accordance with ASTM-E-595.

4.7.2.5.2 Odor. Material samples shall meet the requirements of 3.4.2.2 when tested in accordance with NHB 8060.1, test 6.

4.7.2.5.3 Toxicity. Material samples shall meet the requirements of 3.4.2.3 when tested in accordance with NHB 8060.1, test 7.

4.7.3 Optical inspections.

4.7.3.1 Change in optical transmittance. This test shall evaluate the change of optical power (transmittance) level of the fibers due to exposure to one or more inspection (mechanical and environmental) tests (see 3.6.1). The wavelength tested shall be as specified in the applicable specification sheet (see 3.1). The periodicity of the measurement shall be appropriate for the test method (see measurement 2012 in MIL-STD-1678-2) and as approved by the qualifying activity.

4.7.3.1.1 Method. The change in optical transmittance shall be measured during and after the test (from a baseline obtained before each test) per TIA/EIA-455-20 for transmitted power adhering strictly to the setup and test procedure specified in Measurement 2102 of MIL-STD-1678-2.

4.7.3.2 Attenuation rate (see 3.6.2). The attenuation rate of each individual fiber shall be measured in accordance with measurement 2106 of MIL-STD-1678-2.

4.7.3.2.1 Attenuation rate (for Type I fiber only). Light launch conditions utilizing beam optics preferred.

4.7.3.2.2 Attenuation rate (for Type II fiber only). Light launch conditions shall utilize a higher order mode filter.

4.7.3.2.3 Attenuation uniformity. The attenuation uniformity of each individual fiber shall be measured in accordance with TIA-455-78. Unless otherwise specified, the attenuation uniformity shall be measured at a wavelength of 1300 nm (see 3.6.2.1).

4.7.3.3 Numerical aperture (for type I fiber only). The numerical aperture shall be determined in accordance with TIA/EIA-455-177 (see 3.6.3).

4.7.3.4 Bandwidth (for type I fiber only). The Type I fiber bandwidth shall be determined for both overfill and restricted (either RML or EMBc) launch in accordance with TIA/EIA-455-204. For restricted launch, TIA-455-220 may be used in lieu of TIA/EIA-455-204. The bandwidth shall meet the requirements specified in 3.1 and 3.6.4.

4.7.3.5 Macrobend attenuation. The macrobend attenuation of each individual fiber shall be measured in accordance with TIA-455-62. Launch conditions shall be in accordance with 4.7.3.1.1. Macrobend attenuation shall meet the requirements specified in 3.6.5.

4.7.3.6 Chromatic dispersion. The chromatic dispersion characteristics shall be determined in accordance with TIA-455-175 using Methods A, B, or C for Type I and Type II fibers (see 3.6.6). If an overfill launch is not utilized for Type I (multimode) fiber, a single mode launch shall be utilized and the measured results corrected using the procedure in Appendix A. If Type I (multimode) fiber is measured on chromatic dispersion instrumentation with a single mode launch condition, then conversions shall be performed on measurement data per appendix A.

4.7.3.7 Cutoff wavelength (for type II fiber only). The cutoff wavelength of Type II fibers shall be determined in accordance with TIA-455-80 (see 3.6.7).

4.7.3.8 Transient attenuation (for type I fiber only). The transient attenuation shall be measured as follows. The attenuation shall be measured in accordance with TIA-455-78 method B using overfilled launch conditions without mode filter or cladding mode strippers. Then the attenuation of the sample shall be measured in accordance with TIA-455-78, method B. The transient attenuation is defined as the difference in the two attenuation values obtained (see 3.6.8).

4.8 Environmental inspections.

4.8.1 Thermal shock. The fibers shall be tested in accordance with TIA-455-71 using test condition A-0 (see 3.7.1). The temperature extremes shall be the specified storage temperature extremes (see 3.1). The change in optical transmittance shall be measured after the test.

4.8.2 Temperature humidity cycling. The fibers shall be tested in accordance with MIL-STD-1678-3 measurement 3302.

4.8.3 Temperature cycling (see 3.7.3). The fibers shall be tested in accordance with MIL-STD-1678-3 measurement 3301.

4.8.4 Life aging. The fibers shall be tested in accordance with MIL-STD-1678-3 measurement 3303. Temperature shall be +95°C +3°C, ---0°C. The time shall be 500 hours. The frequency of change in optical transmittance measurements shall be daily (see 3.7.4).

4.8.5 Fluid immersion aging. The fiber shall be immersed in the specified fluids(s) for the duration and temperature as specified (see 3.1) in accordance with TIA-455-74. The samples shall be dried or drained as recommended in the test procedure. After a minimum 24 hour period, the samples shall be tested in accordance with TIA-455-28 (see 3.7.5).

4.8.6 Nuclear radiation resistance (see 3.7.6). The fibers shall be tested for susceptibility to gamma radiation, prompt gamma radiation, and neutron radiation in accordance with TIA/EIA-455-64 (see 3.7.6). Test conditions shall be as specified (see 3.1). Optical characteristics shall be verified at the low operating temperature and at +25°C. The change in optical transmittance shall be measured during and after the test. If the change in optical transmittance at +25°C is greater than the change in optical transmittance at the low operating temperature, the fiber shall be tested at the high operating temperature.

4.8.7 Fungus resistance (see 3.7.7). Fibers composed of materials not listed as fungus inert in guideline 4 of MIL-HDBK-454 shall be tested in accordance with MIL-STD-1678-3 measurement 3401.

4.8.8 Dynamic tensile strength. Fifteen fiber specimens shall be preconditioned in 50 percent relative humidity for a minimum of 12 hours. The specimens shall then be tested in a 50 percent RH environment in accordance with TIA-455-28. The mean fracture strength and Weibull modulus shall be calculated (see 3.7.8).

4.8.9 Storage temperature (see 3.7.9). The fibers shall be tested in accordance with the conditions and procedure specified in table VI. Change in optical transmittance shall be measured before and after each 120 hour temperature plateau.

TABLE VI. Storage temperature test condition schedule and soak times.

Step	Action	Temperature (C°)	Duration (hours)
1	Maintain	Room ambient	3
2	Ramp to	Low storage temp +0, -3	1.5
3	Maintain	Low storage temp +0, -3	120
4	Ramp to	25 ±2	1.5
5	Maintain	25 ±2	3
6	Ramp to	High storage Temp +3, -0	1
7	Maintain	High storage temp +3, -0	120
8	Ramp to	25 ±2	1
9	Maintain	25 ±2	3

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)

6.1 Intended use. The optical fibers covered by this specification are intended for use in any application where their performance characteristics are required. The fibers are suitable for installation on aerospace systems within the limitations of applicable performance requirements.

6.1.1 Temperature rating. Temperature ratings as specified in specification sheets pertaining to this specification represent the maximum permissible operating temperature range of the fiber.

6.1.2 Materials compatibility. The coating of the fibers covered by this specification may be degraded by certain fluids or compounds. If such degradation occurs, the fluids or compounds and the conditions necessary for failure should be added to the specification sheet as a precautionary note.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.

b. Packaging required (see 5.1).

c. Applicable specification sheet number, title, and date.

d. Applicable specification sheet PIN.

e. Quantity of fiber required.

f. Color coded coating of the optical fiber, if specified (see 3.8).

g. Equivalent test methods as approved by the qualifying activity, if other than as specified (see 4.7).

h. Exceptions, if any, to the optional provisions of this specification including:

(1) Exceptions to identification of product requirements (see 3.6) if applicable.

(2) Applicable minimum length requirements, if other than specified.

(3) Responsibility for inspection.

(4) Special preparation for delivery requirements, if applicable (section 5).

i. Any data requirements.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 49291 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime-VQP, 3990 East Broad Street, Columbus, OH 43218-3990, or by email to vqp.chief@dla.mil.

6.3.1 Conformity to qualified sample. It is understood that fiber supplied under contract is identical in every respect to the qualification sample tested and found satisfactory, except for changes previously approved by the Government. Any unapproved change from the qualification sample is cause for rejection.

6.3.2 Forwarding of qualification samples. Samples and the manufacturer's certified test reports should be forwarded to the testing laboratory designated in the letter of authorization from the activity responsible for qualification (see 6.3), plainly identified by securely attached, durable tags marked with the following information:

a. Sample for qualification test

b. Fiber, Optical, General specification for

c. Specification sheet PIN

d. Manufacturer's name and code number

e. Manufacturer's part number.

f. Comprehensive description and prime manufacturer's name and formulation number of the base materials from which the product is made. This information will not be divulged by the Government.

g. Place and date of manufacture of sample.

h. Submitted by (name) (date) for qualification tests in accordance with the requirements of this specification under authorization (reference authorizing letter).

6.4 Definitions. Definitions of terms are in accordance with TIA-440.

6.4.1 Cladding ovality. The cladding ovality is the measure of the degree of roundness of the cladding. It is expressed as the difference between the largest cladding diameter and the cladding diameter measured at right angles to it, all divided by the average of the two values.

6.4.2 Core/cladding offset. The core/cladding offset is the distance between the central axis of the core and the central axis of the cladding.

6.4.3 Core ovality. The core ovality is the measure of roundness of the core. It is expressed as the difference between the largest core diameter and the core diameter measured at right angles to it, all divided by the average of the two values.

6.4.4 Overall coating concentricity error. Overall coating concentricity error (previously called overall coating concentricity ratio) is determined by measuring the minimum wall thickness (min) and the maximum wall thickness (max) and dividing the minimum by the maximum value. This error is expressed in microns.

6.4.5 Transient attenuation. Transient attenuation, in Type I fiber, is the increase (or decrease) in attenuation from the steady-state attenuation because of the over (or under) excitation of the lossy high order propagating modes compared with the steady-state distribution. The steady-state distribution is the condition in which the relative power distribution among the propagating modes is independent of longitudinal distance.

6.5 Environmentally preferable material. Recycled, recovered, environmentally preferable, or biobased materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

6.6 Subject term (key word) listing.

Aperture, numerical
Attenuation, optical
Bandwidth, fiber
Coating material
Coating, fiber
Cladding
Core
Diameter, cladding
Diameter, core
Distortion, pulse
Fiber, plastic clad silica
Graded index profile
Inclusion
Microbending
Microbend loss
Profile, index
Profile, refractive index
Refraction, index of
Volume, mode

6.7 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

CHROMATIC DISPERSION

A.1. SCOPE

Chromatic dispersion of a Type I graded index multimode fiber can be approximated by measuring the chromatic dispersion using a single mode launch condition and calculating the composite chromatic dispersion based on the fiber characteristics. This method provides approximate results which are sufficient for this specification.

A.2. MEASUREMENT

The single mode launch chromatic dispersion characteristics of a Type I (multimode) fiber shall be determined in accordance with TIA-455-175 Methods A, B, or C, with the exception that the following single mode launch condition shall be utilized.

For a single mode launch condition, two sections of a Type II (single mode) fiber are utilized, one at each end of the Type I (multimode) fiber test specimen. Each Type II (single mode) fiber section shall be greater than 2.0 meters in length. The Type II (single mode) fiber sections should have similar glass composition as the Type I (multimode) fiber test specimen.

The light source is coupled into one of the Type II (single mode) fiber sections. This combination of light source and Type II (single mode) fiber is now the single mode light source. The output end of the Type II (single mode) fiber section is coupled to the input end of the Type I (multimode) fiber test specimen. The coupling shall insure that the Type II (single mode) fiber core is centered onto the core of the Type I (multimode) fiber test specimen.

The second Type II (single mode) fiber section is coupled to the detector system. This combination of detector system and Type II (single mode) fiber is now the single mode detector system. The input end of the detector system Type II (single mode) fiber is coupled to the output end of the Type I (multimode) fiber test specimen. The coupling shall insure that the Type II (single mode) fiber core is centered onto the core of the Type I (multimode) fiber test specimen.

Using the above described single mode light source and single mode detector system configuration, chromatic dispersion is measured in accordance with TIA-455-175 Methods A, B, or C. The chromatic dispersion characteristics measured this way are designated as the single mode launch chromatic dispersion characteristics:

$\lambda_{oo} =$ single mode launch zero-dispersion wavelength

$S_{oo} =$ single mode launch dispersion slope at zero-dispersion wavelength

A.3. FIBER CHARACTERISTICS

The following characteristics of the Type I (multimode) fiber test specimen are required for the calculations:

$g =$ index profile parameter (typically ~ 2.1)

$\lambda_c =$ zero-dispersion wavelength of cladding material (~1273 nm for pure silica)

A.4. CALCULATIONS

The approximate composite chromatic dispersion of the Type I (multimode) fiber test specimen is calculated using the following equations:

$$\delta_c = \frac{\lambda_{oo} - \lambda_c}{\lambda_{oo}}$$

$$\lambda_o = \lambda_{oo}\left[1 - \frac{\delta_c}{g+1}\right]$$ composite zero-dispersion wavelength

$$S_o = S_{oo}\left[1 + \frac{2\delta_c}{g+1}\right]$$ composite dispersion slope at λ_o

Where:

$\lambda_{oo} =$ single mode launch zero-dispersion wavelength (measured)

$S_{oo} =$ single mode launch dispersion slope at λ_{oo} (measured)

$g =$ index profile parameter of Type I fiber test specimen (characteristic)

$\lambda_c =$ zero-dispersion wavelength of cladding material (characteristic)

Units:

$\lambda =$ wavelength in nm (nanometers)

$S =$ slope in ps/nm^2-km

CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - SH
Air Force - 85
NASA - NA
DLA - CC

Preparing activity:
DLA - CC

(Project 6010-2015-001)

Review activities:
Navy - AS
Air Force – 02, 13, 19, 33, 93, 99
DIA - DI

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.